DESIGN OF A MODERN STORM DRAINAGE SYSTEM USING PERMEABLE CONCRETE AND COCONUT COIR FIBER AS SUSTAINABLE MATERIAL LOCATED IN BARANGAY SAN VICENTE, SANTA MARIA, BULACAN

A Research Proposal

Presented to the Faculty of Civil Engineering Division

La Concepcion College

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Bachelor of Science in Civil Engineering

Major in Construction Engineering

and Management

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2025

RECOMMENDATION

This is to certify that this research entitled "DESIGN OF A MODERN STORM DRAINAGE SYSTEM USING PERMEABLE CONCRETE AND COCONUT COIR FIBER AS SUSTAINABLE MATERIALS LOCATED IN BARANGAY SAN VICENTE,SANTA MARIA, BULACAN", prepared and submitted by Edmund Ellison S. Dizon, Jessa Mae C. Perseverancia, Jhon Paul P. Terrayo and Adriane G. Tiongson, have been examined and PASSED the Pre-Oral Defense.

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CERTIFICATE OF ORIGINALITY

This certificate demonstrates the fact that the work was original to the researchers and that no other individual or group has written or published it before. Additionally, it declares that until proper acknowledgement has been given to them, no honors or recognition from other universities, colleges or higher education institutions were claimed here.

On top of that, we claim that our study's intellectual content is the product of our hard work, which requires using both simple terminology and efficient presentation methods in addition to the group's original ideas.

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CHAPTER 1

INTRODUCTION

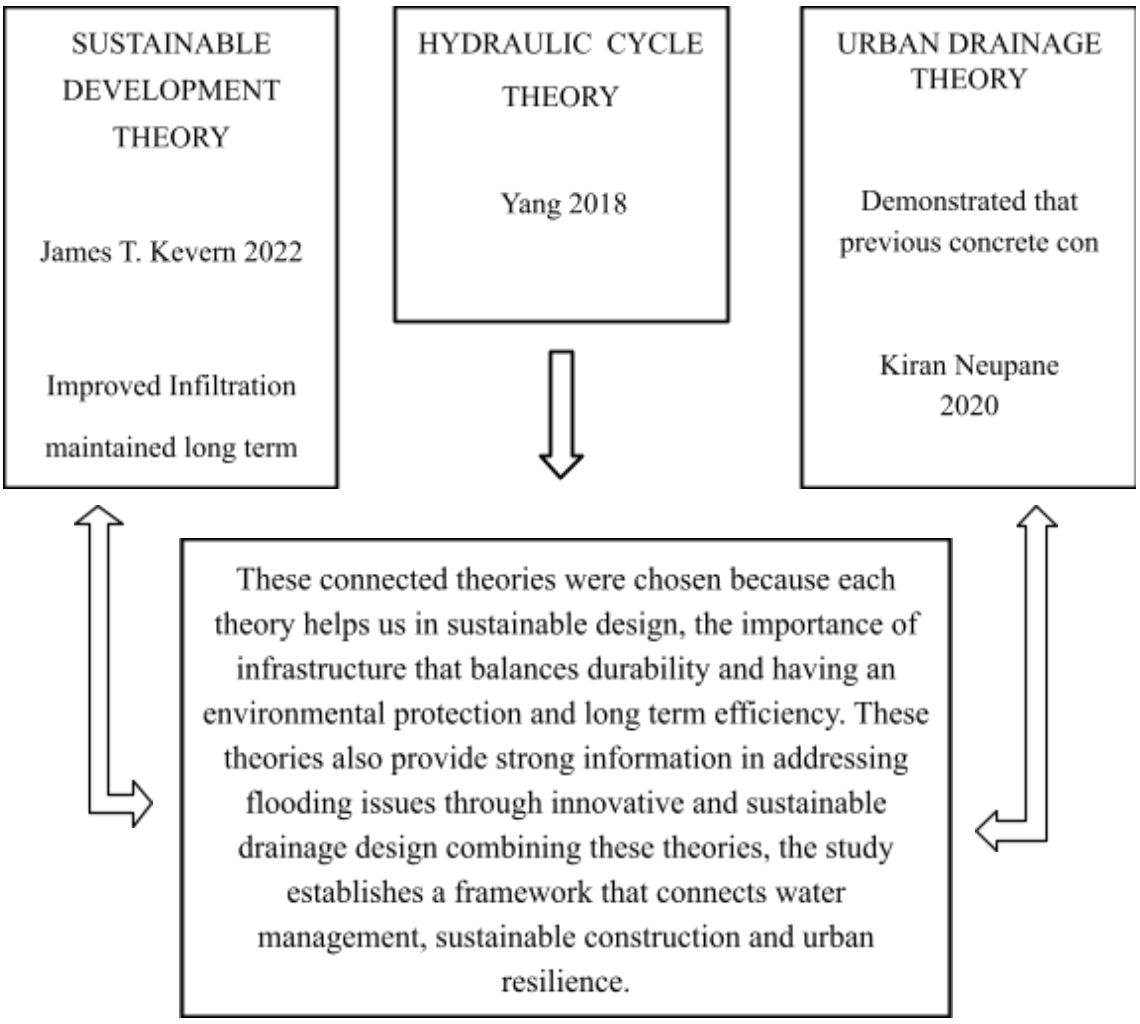
Barangay San Vicente, Santa Maria, Bulacan is one of the several low-lying places in the country where flooding occurs. One major reason for such perennial problems, which have already been identified by many concerned residents, is the state of their antiquated and inadequate drainage systems that could no longer accommodate volumes of stormwater. The situation sits on top of a rapidly developing urban area plus increased effects from climate change. The damage that flooding has brought to this area damage property wherein livelihoods have been disrupted with health and safety risks inflicting pain on the residents. This study attempts to come up with an improved design of the storm drainage system using permeable concrete and coconut coir fiber as sustainable material to improve the specific needs and conditions of Barangay San Vicente. The study aims to generate a feasible, sustainable solution toward reducing the risks of flooding, together with infrastructure protection and safety improvement for the general community. Specifically, it seeks to address current drainage setup weaknesses that support long-term flood management as a facilitator of more resilient and sound urban planning environmentally in the barangay.

BACKGROUND OF THE STUDY

Our research intends to design a new storm drainage which is inspired by functional

and more sustainable features using permeable concrete and coconut coir fiber. These projects will be designed to be practical as well as resilient against floods and benefit the community in multiple ways. At the core of this design is a new storm drainage system that filters solid and liquid waste to prevent flooding. These drainage systems are all constructed with concrete and steel for stronger outcome and last longer than old drainage.

Theoretical Framework


SUSTAINABLE DEVELOPMENT THEORY
James T. Kevern 2022
Improved Infiltration maintained long term
HYDRAULIC CYCLE THEORY
Yang 2018
URBAN DRAINAGE THEORY
Demonstrated that previous concrete con
Kiran Neupane 2020
These connected theories were chosen because each theory helps us in sustainable design, the importance of infrastructure that balances durability and having an environmental protection and long term efficiency. These theories also provide strong information in addressing flooding issues through innovative and sustainable drainage design combining these theories, the study establishes a framework that connects water management, sustainable construction and urban resilience.

IPO Conceptual Framework

INPUT	PROCESS	OUTPUT
1. What is the demographic profile of the respondents in terms of: 1.1 Age 1.2 Gender 1.3 Length of Residency 2. How do the respondents assess the problem in the Old Storm Drainage system in terms of: 2.1 Health and Safety 2.2 Living Condition 2.3 Effectiveness in Flooding 3. How do the following factors of coconut coir fiber affects in designing and testing in terms of: 3.1 Compressive Strength 3.2 Work-ability 3.3 Improve Design of Storm Drainage system 4.How effective is the proposed drainage system in terms of; 4.1 Reducing surface run off 4.2 Reduce flooding	1. Collection and Preparation of Materials 1.1 Gather locally available coconut husks from Barangay San Vicente. 1.2 Extract and clean the coconut coir fibers. 1.3 Dry and cut the fibers into uniform sizes suitable for concrete mixing. 2. Concrete Mix Design and Preparation 2.1 Prepare concrete mixes with varying proportions of coconut coir fiber 2.2 Ensure consistent mixing to achieve uniform distribution of fibers within the concrete mixture. 3. Casting and Curing of Concrete Samples 3.1 Pour the prepared mixtures into drainage mold specimens. 3.2 Allow proper curing under standard conditions for a specified number of days 4. Testing and Evaluation 4.1 Conduct compressive strength, tensile strength, and water absorption tests on the cured samples. 4.2 Record and analyze results to determine the effect of coconut coir fiber on the performance of concrete. 5. Data Analysis and Interpretation 5.1 Compare results between control and fiber-reinforced samples. 5.2 Evaluate improvements in	N/A

Statement of the Problem

This research proposed to design a new storm drainage system in Barangay San Vicente, Santa Maria, Bulacan, utilizing permeable concrete. Specifically, the study seeks to answer the following questions:

1. What is the demographic profile of the respondents in terms of:
    1.1 Age
    1.2 Gender
    1.3 Length of Residency
2. How do the respondents assess the problem in the Old Storm Drainage system in terms of:
    2.1 Health and Safety
    2.2 Living Condition
    2.3 Effectiveness in Flooding
3. How do the following factors of coconut coir fiber affect designing and testing in terms of:
    3.1 Compressive Strength
    3.2 Workability
    3.3 Improve Design of Storm Drainage system
4. How effective is the proposed drainage system in terms of;
    4.1 Reducing surface runoff
    4.2 Reduce flooding

Objectives of the Study

The objective of this study is to design a new storm drainage system in Barangay San Vicente, Santa Maria, Bulacan, using permeable concrete to enhance flood control, water infiltration, and environmental sustainability. Specifically, this study aims to:

1. Evaluate the drainage performance of permeable concrete compared with the existing storm drainage system in terms of water infiltration, flood reduction, and public health improvement.
2. Assess the effects of incorporating permeable concrete on the mechanical properties, permeability, and durability of the material used.
3. Determine how the proposed drainage system can minimize waste accumulation and improve the efficiency of water flow.
4. Develop an optimized design for a permeable concrete-based drainage system suited to the environmental and community conditions of Barangay San Vicente.

HYPOTHESIS

Ha. There is a significant effect on the effectiveness of the proposed drainage system in reducing surface runoff and flooding, indicating improved drainage performance, reduced surface runoff, and better flood mitigation in Barangay San Vicente, Santa Maria, Bulacan.

Ho. There is no significant effect on the effectiveness of the proposed drainage system in reducing surface runoff and flooding, indicating no improvement in drainage performance and flood mitigation in Barangay San Vicente, Santa Maria, Bulacan

SIGNIFICANCE OF THE STUDY

This study aims to address a pressing issue in Barangay San Vicente Santa Maria Bulacan, which is the frequent flooding, so we proposed a design of a new storm drainage system. The significance of this research further views for different contributors by providing useful, formidable and great help to the following:

Community Safety and Well-being Residents of Barangay San Vicente Santa Maria Bulacan will benefit by improving the storm drainage system using permeable concrete and coconut coir fiber as sustainable material to minimize property damage, health risk and enhancing their safety and quality of life.

Economic Benefits A modernized drainage system will increase the property value of the area because it will allow the property to attract investment by demonstrating the community's commitment to sustainable infrastructure. Additionally, promoting the use of sustainable materials can reduce the costs, which can lead to more affordable infrastructure projects

Civil Engineers and Urban Planners. This research offers engineers and planners the chance to discover alternative materials used to create a new storm drainage system which is less cost but same in quality of concrete by using coconut coir fiber as a sustainable material. Innovative solutions for creating more sustainable infrastructure by using sustainable materials in construction.

Educational Contribution This research provides more knowledge and insights into the application of permeable concrete and coconut coir fiber as sustainable material in stormwater management, serving as a reference for students, engineers, environmentalists, and policymakers interested in sustainable urban development.

Policy and Infrastructure Development The purpose and design proposed in this study can serve as a model for local government units (LGUs) and urban planners in Bulacan and similar flood-prone areas, promoting the adoption of low cost, resilient infrastructure solutions in future projects. It will also serve as an example for other barangay in Santa Maria Bulacan to build their own new storm drainage system.

SCOPE AND LIMITATIONS OF THE STUDY SCOPE

This research centres on the design of a modern storm drainage system in Barangay San Vicente, Santa Maria, Bulacan, making use of permeable concrete and coconut coir fiber as sustainable material to help address persistent flooding. It

includes an evaluation of the existing drainage conditions, an assessment of permeable concrete in improving water infiltration, and the application of eco- friendly materials to strengthen durability and sustainability. The study aims to demonstrate how the proposed system can enhance infiltration, minimize waste buildup, and provide a reliable, long-term solution for improving flood resilience and protecting the community.

LIMITATIONS

This study is limited to Barangay San Vicente, Santa Maria, Bulacan, and results may not be directly applicable to other areas with different environmental conditions. The focus is on the design and feasibility of a modern storm drainage system using permeable concrete and coconut coir fiber as a sustainable material, without covering actual construction, long-term monitoring, or cost implementation. The constraints may affect the scalability and effectiveness of the proposed designs, but the study aims to offer a foundation for future work in sustainable flood mitigation.

DEFINITION OF TERMS

Barangay San Vicente in Santa Maria, Bulacan, like many low-lying areas in the Philippines, faces the persistent threat of flooding. To combat this, innovative solutions are being explored, focusing on modern storm drainage systems that utilize permeable concrete and coconut coir fiber as a sustainable material. Understanding the terminology associated with these approaches is crucial for effective implementation and community engagement. This article defines key terms relevant to flood mitigation in the context of Barangay San Vicente's proposed drainage system.

Groundwater Recharge:

The process of replenishing underground aquifers with water. By using permeable concrete and other infiltration techniques, the proposed drainage system in Barangay San Vicente can enhance groundwater recharge, contributing to a more sustainable water management strategy.

Runoff:

This is the portion of rainfall or other precipitation that flows over the ground surface. Effective flood mitigation in Barangay San Vicente requires managing runoff to prevent it from overwhelming the existing drainage infrastructure and causing flooding.

Coconut Coir Fiber:

Coconut fiber, also known as coir, is derived from the fibrous husk of the coconut plant and is used in the production of coir. It is an environmentally friendly, locally available, and cost-effective alternative to conventional materials. Coconut coir is abundant in Barangay San Vicente, Santa Maria, Bulacan, which reduces transportation costs and supports local farmers by utilizing agricultural waste that would otherwise be discarded. Coconut coir fiber improves the tensile strength, crack resistance, and durability of concrete. It helps control shrinkage and prevents cracking, which is essential for drainage structures exposed to constant water flow and varying weather conditions.

Permeable Concrete:

A specialized type of concrete that allows water to pass through its surface. By using permeable concrete in pavements and other surfaces, the proposed drainage system in Barangay San Vicente can reduce surface runoff, allowing water to infiltrate into the ground and replenish groundwater reserves.

Storm Drainage System:

This refers to the network of structures designed to collect and channel stormwater runoff away from populated areas. In Barangay San Vicente, a modern storm drainage system aims to efficiently manage rainwater, preventing it from accumulating and causing floods.

CHAPTER 2

Foreign Literature

A study by Hilal El-Hassan (2022), The study of permeable pavement systems (PPS) has gained attention as sustainable urban drainage solutions for effective stormwater management. A bibliometric and systematic review of studies from 2000 to 2021 revealed that modifications within PPS layers and the use of innovative filters enhance contaminant removal efficiency. However, impermeable soils and small pore sizes limit infiltration rates, while clogging often occurs in the top 1.5–2.5 cm layer. The use of recycled aggregates improves permeability but slightly reduces compressive strength. The study highlights research gaps, maintenance strategies, and sustainable design improvements essential for advancing efficient and eco-friendly drainage systems to prevent flooding, (Hilal El-Hassan, 2022).

Wu, Y., (2025), focus on maintenance practices, and climate resilience benefits. This study helps to improve the living conditions of the community of the affected of the flooding because of the old drainage system. Although optimized structural designs balance load capacity and infiltration, clogging still limits long-term performance. Maintenance strategies like vacuuming and pressure washing are essential for sustaining permeability. (Wu, Y., 2025),

According to Wong, K.S.(2025), The study outcomes permeable concrete in reducing stormwater and wastewater pollution require an applicable response, not only the optimized mixture design, strength, and physical properties of permeable concrete

but also the effect of different types of adsorbents on engineering properties and environmental aspects of this system. (Wong, K.S, 2025),

A foreign study of Cheddie d. (2020), The study examined whether the Coconut fiber/husk filters can be appropriate in handling high-turbidity stormwaters without becoming quickly clogged. This low-impact filter can polish stormwater, removing high turbidity and contaminants. Three filter units were constructed and tested at Tobago for urban runoff recycling and non-potable supply to improve water, sanitation, and reduce the risk of flooding. This study can help to improve our storm drainage design in San Vicente, Sta. Maria, Bulacan. (Cheddie d. 2020).

According to Mohamad H.J (2024), This study focused on permeability of porous concrete to evaluate the effectiveness of porous concrete drainage system. They examined the physical drainage model, which focused on various sizes of porous cube (100 cm x 30 cm x 75 cm), (150 cm x 300 cm x 75 cm) and (200 cm x 300 cm x 75 cm) and various weir heights which are 5 cm,10 cm and 15 cm to stabilize the flow and create uniform flow. Various inflow rates were successfully carried out in accordance with the necessary criteria. (Mohamad H.J, 2024),

Local Literature

A study by Simango, Saimon Jay C. (2025), The study aimed to develop and evaluate a coconut fiber-reinforced porous concrete mix as a sustainable alternative for sidewalks and drainage covers in Brgy. Pag-Asa, Dinalupihan, Bataan. Traditional concrete, being impervious, contributes to excessive surface runoff and local flooding,

which negatively impacts both the environment and infrastructure. The study aimed to create a concrete mix that promotes water permeability while maintaining sufficient structural strength

using locally available materials such as Portland cement, ¬æ-inch coarse aggregates, No. 4 sieve fine aggregates, water, and coconut fiber. Industry standards from ASTM and ACI were used to guide the testing and validation process. The research demonstrates that the integration of agricultural waste materials such as coconut fiber in concrete production can support sustainable urban development while addressing pressing climate and infrastructure challenges. (Simsuangco, Saimon Jay C. 2025).

A local literature by Ramos, Ricky Boy D. (2023), This study was conducted to calculate the maximum load bearing capacity of the permeable concrete used in the road and drainage system and to test the infiltration rate of the permeable concrete. To identify the major issue of water stagnation and to provide a solution, a thorough investigation was conducted in the area, focusing on the Barangay Parian Mexico, Pampanga. In order to support the study and determine the appropriate mixture ratio for permeable concrete, data were gathered and analyzed. (Ramos, Ricky Boy D. 2023).

According to Andaya, Miguel t.(2020), This study conducted several flexural strength tests and falling head tests to assess the flexural strength and permeability of permeable concrete. The data and results from the tests were compared with the data gathered from Philippine Atmospheric, Geophysical and Astronomical Services

Administration (PAGASA) and Department of Public Works and Highways (DPWH) to determine the efficiency of permeable concrete in reducing the occurrence of flood in Intramuros, Manila.(Andaya, Miguel t. 2020).

Zaiba, Fathima (2020), Discuss the Pervious concrete pavement is a effective means to address important environmental issues and support green, sustainable growth. By capturing storm water and allowing it to sleep into the ground, porous concrete is instrumental in recharging groundwater, reducing storm water runoff. Storm drainage with porous concrete base can infiltrate rainwater into the ground and recharge the ground water effectively. (Zaiba, Fathima 2020).

According to Castro, Al Patrick C. (2023), This research was conducted to investigate the feasibility of permeable concrete for sustainable stormwater management in a university setting, particularly in De La Salle University – Laguna Campus. The Storm Water Management Model (SWMM) was utilized to simulate different rainfall scenarios on selected little to no vegetation with increasing permeable pavement area coverage. The permeable concrete was concluded to be effective in surface runoff infiltration, reduction, and storage, which is beneficial for long-term stormwater management and flood prevention strategies. (Castro, Al Patrick C.2023),

Foreign Study

Zhang, Hanwen (2024), The study introduces a permeable concrete skeleton structure that considers compressive strength and permeability coefficient. Moreover, the proportion design method is adjusted based on the spherical characteristics of the

aggregates, which are analyzed using Image Pro-Plus image processing technology. This study gives ideas in our research about the strength of ongoing design of a storm drainage system and the permeability coefficient of the storm drainage system. (Zhang, Hanwen 2024)

According to Ramezani, R. (2025), This study presents the effect of using fibers in porous concrete used in surface drainage structures was evaluated. In this topic, our research has an idea improving a storm drainage system because the permeability and compressive strength measured correctly. (According to Ramezani, R. 2025).

A Foreign Study by kurnianingsih, Oktavia (2024), This research introduces an innovative solution to enhance drainage channel performance by using porous concrete also known as permeable concern, which allows water to pass through its voids. This study examined the infiltration of a drainage which helped our research to test the capabilities of a drainage system. (Kurnianingsih, Oktavia 2024).

Abdel Rahman, Rehab O. (2023), Permeable concrete is a class of materials that has long been tested and implemented to control water pollution. Its application in low-impact development practices has proved its efficiency in mitigating some of the impacts of urbanization on the environment, including urban heat islands, attenuation of flashfloods, and reduction of transportation-related noise. Additionally, several research efforts have been directed at the dissemination of these materials for controlling pollution via their use as permeable reactive barriers, as well as their use in the treatment of wastewater and water purification. This study helps to identify the

workability of permeable concrete use for storm drainage. (Abdel Rahman, Rehab O.2023).

According to Habibunnisa, Syed (2020), Discuss the role of coconut fiber in the concrete. This topic gives us an idea about coconut coir fiber for improving the strength in concrete like we use permeable concrete. This topic also discusses the correct mixture of fiber and a concrete. (Habibunnisa, Syed 2020).

Local Study

Santos, Odyson D. (2021), This study aims to develop a study on the aggregates on porous concrete to serve as a basis for further development on flood control project focusing in drainage in manila. The study aims to determine the best size of aggregates to be used satisfactorily with the flexural strength and permeability rate for designing a drainage system. This study supports our present research about drainage using a porous concrete or also called permeable concrete. (Santos, Odyson D. 2021). According to Daniyal et al, (2020), This study reviews the key properties of pervious concrete, the factors influencing its performance. Additionally, it explores methods to enhance its durability and lifespan Furthermore, this study discusses critical parameters such as the water-to-cement ratio, aggregate characteristics, admixtures, compaction methods, and curing techniques that influence the overall performance of pervious concrete. This study helps our present research about permeable concrete, how to work and discuss the performance of permeable concrete.

A local study by Orozco, Christian, (2021), This study discusses the environmental

benefits of using pervious concrete in the Philippines for pavement applications. Laboratory experiments were carried out to quantify and assess infiltration, noise reduction, temperature and compressive strength of pervious concrete with varying mix proportions of water, cement, coarse aggregates and fine aggregates. Pervious concrete is a type of concrete having an increased number of interlocking voids as compared to conventional concrete. It is popular in many countries because of its advantages over conventional concrete and asphalt pavements. According to Benedict E.(2022) ,This study follows a corrective step by step design approach of drainage facilities for prevention and control of flood more especially in road pavements. This study gives idea for our research, giving a step-by-step procedure about designing a storm drainage using permeable concrete.

A local study by Sharma Et al (2021), Discuss the permeable concrete how effectively in drainage system design. This study finds that permeable concrete is for long term. This research gives idea in present research how effective permeable concrete in drainage systems.

Synthesis Of the Study

A study of foreign literature and local Literature emphasizes that Porous concrete also called a permeable concrete play a crucial role in workability , improving quality of a storm drainage system using a permeable concrete and coconut coir fiber as a sustainable material and providing health and safety for the community. The findings of permeable concrete and coconut coir fiber for drainage systems

effectiveness is good as we follow the mixture of the materials, we use for designing a drainage system, as coconut coir fiber is suitable for permeable concrete, improving the structural performance. The Research established on these finding to proof that permeable concrete and coconut coir fiber is effective in our storm drainage system in San Vicente, Sta Maria, Bulacan. This Study target the improvement of storm drainage design to solve the suffering community in Brgy San Vicente because of low quality drainage system

CHAPTER 3

RESEARCH METHODOLOGY

This research methodology combines qualitative and quantitative approaches focusing on on-site analysis, questionnaires or surveys, and structural evaluations. The aim is to integrate coconut coir Fiber as sustainable materials and create a coconut coir Fiber as sustainable material that meets the people's needs while focusing on safety standards.

Research Design

This study uses a mixed-methods approach for the modern storm drainage system using permeable concrete and coconut coir Fiber as sustainable material involves a systematic and structured approach including detailed site assessment to analyze soil and hydrological conditions, followed by the development and optimization of permeable concrete mixes suited for the area's specific infiltration and strength needs. The project employs hydrological modeling to calculate runoff volumes

and size the drainage component accurately.

Laboratory testing and pilot implementations are conducted to validate the performance of permeable concrete and drainage efficiency. The design process integrates coconut coir Fiber selection and considers system layout factors such as slope, subbase, and underdrain installation to ensure effective stormwater infiltration and minimize flooding risk Sample and Population

This study will focus on a modern storm drainage system using permeable concrete and coconut coir Fiber as sustainable material in Barangay San Vicente, Santa Maria, Bulacan.

The sample refers to the physical permeable concrete materials tested, with varying aggregate sizes and curing times, to evaluate their performance in terms of infiltration rate and compressive strength. The population is the entire geographical area and community of Barangay San Vicente, including its land characteristics, population density, rainfall patterns, and stormwater runoff conditions that the drainage system aims to service.

Research Instrument

This study will use surveys and design software tools as research instruments. Surveys will gather feedback from community members and administrators about their needs and preferences for the proposed design. Design Software tools like AutoCAD, and SketchUp will help create and refine the design of modern storm and coconut coir fiber as sustainable material.

Data Gathering

Collecting data starts surveys to gather opinions from the community. And collecting comprehensive site-specific information. The questionnaire will be used to ensure clarity and reliability. Permeable concrete and coconut coir fiber as sustainable material involve comprehensive field measurements and laboratory testing. Field data collection includes measuring road levels, bank and bed levels of drains, water depth, silt accumulation, and drainage dimensions such as width and length at various points within the study area.

Statistical Tool

Includes, Intensity-Duration-Frequency (IDF), will analyze the performance of these permeable and coconut coir fiber. Using the findings, a functional modern storm design with modern amenities will be created, incorporating the coconut coir fiber to enhance storm drainage, sustainability and efficiency.

Intensity-Duration-Frequency (IDF)

$$I = \frac{K \cdot a^T}{(t+b)^d}$$

I - Maximum rainfall intensity

t -Rainfall duration

T – Return period of years

K, a, b, d – location-specific constants that are determined through statistical analysis of local historical

Research Survey Questionnaire

We 4th year student at La Concepcion College are conducting research about Design of Modern Storm Drainage system in barangay San Vicente.

Make sure you answer clearly, and your personal data will be kept confidential and used only for research purposes.

Part 1

A. Demographic Profile

Name(optional)_____

(Please check the appropriate box) Gender:

☐ Male ☐ Female ☐ Prefer not to say

Length of residency in Barangay San Vicente:

☐ Less than 1 year

☐ 1-5 years

☐ 6-10 years

☐ More than 10 years

B. Current Drainage Situation

Please check one box for each question.

1. Does the Old drainage can cause flooding in your area during heavy rain?

☐Yes ☐ No

2. Does your drainage need to redesign to prevent flooding?

☐Yes ☐ No

3. Do you think that the Modern Storm Drainage System will be helpful in your community?

☐Yes ☐No

4. Does the Old Storm Drainage system affect your health and safety?

☐Yes ☐No

5. Do you think waste and garbage affect the drainage system in your area?

☐Yes ☐No

C. Perception of Modern Storm Drainage System

Please check the box that represents your answer based on the rating scale below.

Rating Scale:

5 - Strongly Agree, 4 - Agree, 3 - Neutral, 2 - Disagree,1 - Strongly Disagree

	1	**2**	**3**	**4**	**5**
Water drains quickly after rain because of drainage system.					
The drainage design is appropriate for the daily use of our barangay.					
The modern drainage system has improved sanitation and reduced stagnant water.					
The modern storm drainage system in Barangay San Vicente effectively prevents flooding during heavy rains.					
I am aware of how the new drainage system works in our area.					

D. Effectiveness of the Proposed Drainage system

Please check the box that represents your answer based on the rating scale below.

Rating Scale:

5 - Strongly Agree, 4 - Agree, 3 - Neutral, 2 - Disagree,1 - Strongly Disagree

	1	2	3	4	5
The proposed drainage system will significantly reduce the frequency of flooding in the community.					
The improved drainage design can handle large volumes of stormwater during heavy rains					
The drainage improvements will lessen property damage and road disruption caused by floods.					
The proposed drainage system effectively minimizes the accumulation of surf water during heavy rainfall.					
The new design prevents waterlogging and standing water after rainfall.					

Thank You, your time and honest answers are very important to the success of this research. Thank you for your cooperation and support in helping improve the drainage system in Barangay San Vicente, Sta. Maria, Bulacan